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*Research Article*

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# Occurrence and Distribution of Dry Root Rot in Major Chickpea Growing Regions of Andhra Pradesh

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**ABSTRACT**

*A survey was conducted in rabi 2017 in different chickpea growing districts of Andhra Pradesh viz., Kurnool, Kadapa, Anantapuramu, Pakasam and Guntur. Due to favorable weather conditions and variation in sowing dates in different districts, different crop growth stages i.e. from seedling to podding stage were observed and the disease was observed in all the stages. The mean maximum dry root rot incidence was observed in Anantapuramu (11.50%) and the least in Guntur (6.00%). Disease occurrence was observed irrespective of cropping system, soil types and cultivars. Mostly the disease incidence was low in the irrigated fields compared to rainfed fields.*

***Keywords:*** *Survey, Disease, Distribution, Cropping system and Incidence*

## INTRODUCTION

Chickpea (*Cicer arietinum* L.) is widely cultivated in the world covering more than 50 countries spread over Asia, Africa, Europe, Australia, North America and South America and it is the third most important pulse crop, after dry bean and peas, produced in the world. It accounts for 20 per cent of the world pulses production (Gaur et al., 2014). Among chickpea growing states of India, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Andhra Pradesh, Karnataka, Chhattisgarh, Bihar and Jharkhand contribute more than 95 per cent to the total production. In recent years, the country has witnessed remarkable increase in area, production and productivity of chickpea. India contributes to a major share of the world's chickpea area (70 %) and production (67 %) and continues to be the largest chickpea-producing nation (Dixit et al., 2019).

In India, chickpea occupies an area about 105.60 L ha, production 113.79 L t and productivity 1078 kg $ha^{-1}$ (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, 2017-2018). Chickpea area (35.90 L ha), production (45.95 L t) and productivity (1280 kg $ha^{-1}$) is maximum in Madhya Pradesh (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, 2017-2018).

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In Andhra Pradesh, chickpea occupied an area of 5.20 L ha, production 5.88 L t and productivity 1132 kg $ha^{-1}$ (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, 2017-2018).

Chickpea is a highly nutritious grain legume crop and widely appreciated as a health food. It is a protein-rich supplement to cereal-based diets, especially to the poor in developing countries, where people are vegetarians or cannot afford animal protein.

Diseases are the most serious limitations to chickpea production causing up to 100 per cent losses. Ecological, environmental and physiological factors and intensity of biotic stresses are known to aggravate the occurrence and severity of the diseases. Though many diseases are reported, only a few such as collar rot (*Sclerotium rolfsii),* wilt (*Fusarium oxysporum* f.sp.*ciceri),* dry root rot *(Rhizoctonia bataticola)*, wet root rot *(Rhizoctonia solani)*, blight (*Ascochyta rabiae),* grey mould *(Botrytis cinerea)* and chickpea stunt may cause severe losses and prevent farmers from realizing the potential yield. Among these, dry root rot and wilt causes severe losses in almost all major chickpea growing states of India. Dry root rot causes 20-30 per cent crop losses in major chickpea growing states of India (Nene et al., 2012).

Among the several soil borne fungal diseases, dry root rot caused by *R. bataticola* (Taub.) Butler is the most severe disease of chickpea especially in the central and southern zones, where the crop is mostly grown in *rabi* season under rainfed conditions. Predominantly, disease appears around flowering and podding stage. The first symptom is yellowing and sudden drying of the plants. The tap root becomes dark brown quite brittle in dry soil and shows extensive rotting resulting in the loss of lateral roots. The lower portion of the tap root is often left in the soil when plant is uprooted (Nene et al., 2012).

In A.P major chickpea growing districts includes Kurnool, Y.S.R Kadapa, Anantapuramu, Prakasham and Guntur and the dry root rot occurrence is severe in this area. This commences to work on this disease to generate basic information on percent disease incidence, to search for an alternate possible approach other than use of fungicides for the management of the dry root rot.

Chickpea diseases may cause yield losses of up to 100 per cent depending on time of infection. The recommended method of managing the diseases is to use resistant varieties. A number of improved chickpea disease-resistant varieties have been multiplied and disseminated to farmers in many districts of India. However, their current prevalence in farmers' fields has not been documented (Ghosh et al., 2013).

*Rhizoctonia* is a genus of anamorphic fungi in the order Cantharellales and family Ceratobasidiaceae. *Rhizoctonia* species do not produce spores, but are composed of hyphae and sclerotia (hyphal propagules), asexual stage of fungi, saprophytic, but some act as facultative plant pathogens causing commercially important crop diseases. The disease has been reported from most chickpea-growing areas in India and other countries like Iran (Kaiser et al., 1968), the USA (Westerlund et al., 1974) and several countries in Asia and Africa (Nene et al., 1996).

The disease was earlier known as "Rhizoctonia wilt" in chickpea; however, later it was named as "dry root rot". The dry root rot was not of much significance in chickpea earlier; however, it has become a major threat to chickpea production in recent years due to altered weather conditions, particularly on the account of longer drought spells. Higher temperature and soil moisture depletion during crop growth period particularly at pre-harvesting stage is predisposing chickpea to dry root rot (Sharma & Pande, 2013). Recent surveys conducted during 2010–2013 indicated widespread and increased incidence of dry root rot in the central and southern states of India (Ghosh et al., 2013). Disease

was found irrespective of soil types, cropping system and cultivars used and incidence ranged from 5 to 50 per cent or more in badly infected soils. Considering the severity and loss caused by *R. bataticola*, it was thought necessary to initiate systematic studies on emerging and destructive dry root rot disease problem occurring in different districts of Andhra Pradesh.

## MATERIALS AND METHODS

Roving survey was conducted during *rabi* 2017-18 in major chickpea growing areas of Andhra Pradesh such as Kurnool, Y.S.R Kadapa, Anantapuramu, Prakasham and Guntur districts, in each district 2 Mandals, in each Mandal two villages and in each village 5 fields were surveyed to study the incidence of dry root disease.

Four $1m^2$ quadrants were randomly selected in each field and infected plants were counted in each quadrant. Based on infected and total number of plants, disease incidence was calculated. Chickpea plants showing the typical dry root rot symptoms and healthy plants were collected from surveyed areas, packed in labeled paper bags.

$$\text{Per cent disease incidence} = \frac{\text{Number of plants infected}}{\text{Total number of plants}} \times 100$$

## RESULTS AND DISCUSSION

A roving survey was conducted during January, 2017 in five major chickpea growing districts of Andhra Pradesh to assess the status of dry root rot incidence under field conditions. The data pertaining to survey is given in Table 1.

It is evident from the table 1 that the mean maximum dry root rot incidence was observed in Anatapuramu (11.50%) followed by Kurnool (9.61%), Kadapa (7.92%), Prakasam (7.50%) and the least was observed in Guntur (6.00%). Out of 22 villages surveyed, the crop was cultivated in black soils in all locations. Significantly highest disease incidence of 19.00% was recorded in Ayyalur of Nandyal mandal, Kurnool district, followed by 15.00% recorded in Peddadoddi village of Gooty mandal, Ananthapur district which was at par with Dhorasanipalle (4.00%) of Prodduitur mandal, Basinepalle (13.33%) of Gooty mandal, Ananthapur district, Valluru (13.33%) of Tanguturu mandal, Prakasam district and Gogulapadu of Rompicherla mandal, Guntur district. Least disease incidence was recorded in Daseripalem (2.00%) of Rompicherla mandal, Guntur district which was at par with Chapirevula (2.33%) of Nandyal mandal, Kurnool district, Cheruvukommapalem (3.00%) of Ongole mandal, Prakasam district and Devagudi of Jammalamadugu, Kadapa district.

In Kurnool significantly maximum incidence was recorded in Ayyalur (19.00%) of Nandyal mandal and the least incidence 2.33% in Chapirevula village of the same mandal. In Kadapa district, the highest incidence was noticed in Dhorasanipalli village (14.14%) and least in Devagudi village (4.00%).

In Prakasam district, maximum incidence was recorded in Vallure village (13.33%) and the least in Cheruvukommapalem (3.00%) of Ongole mandal. In Anantapuramu, highest was found in Peddadoddi with 15.00% incidence and least was noticed in Ayyavaripalli of Guntakal mandal. In Guntur, highest disease incidence was noticed in Gogulapadu village (13.00%) and least in Daseripalem (2.00%).

The per cent disease incidence recorded in each variety varied depending on the place of cultivation. Desi variety was cultivated in 7 villages had disease incidence ranging from 2.00 % in Daseripalem of Rompacherla mandal, Guntur distrcict to 15.00 % in Peddadoddi village of Gooty mandal, Ananthapuramu district.

In Kurnool district chickpea was occupied by desi variety in only one village of surveyed area that is in Venkatagiri village of Kodumure mandal with 10.67% disease incidence where the difference in incidence was significantly, While in Kadapa it ranges

from 7.67% (Ramapuram of Proddutur) to 14.00% (Dhorasanipalle) of Proddutur mandal. While the difference in disease incidence was significant. In Prakasam, desi variety was cultivated only in Kandukuru village of Tanguture mandal where 7.67% disease incidence was noticed while in Anantapuramu it was cultivated in Peddadoddi village of Gooty mandal with the disease incidence 15.00%.

In Guntur district disease incidence in desi cultivar ranged from 2.00% (Daseripalem of Rompicherla mandal) to 13.00% (Rompicherla village of Guntur mandal). Where the difference in disease incidence was significant. The per cent disease incidence recorded in each variety varied depending on the place of cultivation.

JG 11 cultivated in 12 villages recorded the disease incidence ranging from 3.00% Cheruvukommapalem of Prakasam district to 13.33% in Vallure of Tanguture mandal Prakasam district and Basinapalle of Gooty mandal, Anatapuramu district. Disease incidence varied from 2.33% (Chapirevula) of Nandyal mandal to 12.33% (Peddapadu) of Kurnool mandal in Kurnool district, where the difference in disease was significant and 4 % disease incidence was observed in Devagudi village of Kadapa. In Prakasam, the disease incidence varied from 3.00% (Cheruvukommapalem of Ongole mandal) to 13.33% (Vallure of Tanguture mandal) while in Anantapuramu it was from 7.00% (Ayyavaripalle of Guntakal mandal) to 13.33% (Basinipalle of Gooty mandal) the difference in maximum and minimum disease incidence was significant. In Guntur district the disease incidence ranged from 4.33% (Dondapadu of Vinikonda mandal) to 4.67% (Brahmanapalli of Vinikonda mandal).

Cultivars L550, MNK1 and KAK 2 cultivated in Ayyalur of Nandyal mandal Dharmapuram of Jammalamadugu and Chejerla villages recorded per cent disease incidence of 19.00%, 6.00% and 6.00 % respectively.

When compared to all the cultivars, desi variety had recorded minimum disease incidence 2.00% in Daseripalem of Rompicherla mandal and maximum was recorded with L550 variety at Ayyalur of (19.00%) Nandyal mandal, Kurnool district.

There was difference in disease incidence due to variation in location and type of cropping system followed with chickpea. Sorghum-Chickpea cropping system was observed in 3 villages where the per cent disease incidence ranged from 10.67 Venkatagiri village of Kodumure mandal, Kurnol district to 15.00 in Peddadoddi village of Gooty mandal, Anantapuramu district. The difference between maximum and minimum disease incidence was significant.

Maize-Chickpea cropping system was observed 5 villages, where significantly least disease incidence was observed in Chapirevula village (2.33%) of Nandyal mandal, Kurnool district and maximum was observed in Nakkanadoddi village of Guntakal mandal, Anantapuramu district.

Kharif fallow-Chickpea cropping system was observed in 5 villages out of 22 villages surveyed, where the per cent disease incidence ranged from 3.00 in Cheruvukommapalem of Ongole mandal, Prakasam district to 19.00 % in Ayyalur, Nandyal mandal, Kurnool district.

In Kodumure village of Kurnool district Pigeonpea-Chickpea cropping system was observed where 5.67% disease incidence was observed.

Cotton-Chickpea cropping system was observed in 3 villages, where the per cent disease incidence varied from 4.33% to 13.33% the significant difference was observed between minimum and maximum disease incidence.

In 3 villages of Guntur district Blackgram- Chickpea cropping system was observed, where the per cent disease incidence ranged from 2.00 in Daseripalem Gogulapadu village of Rompicherla mandal. Guntur district

where the difference in disease incidence was significant.

Rice-chickpea cropping system was observed in 2 villages out of 22 villages surveyed where the disease incidence ranged from 6.00 % in Dharmapuram village of Jammalamaudugu mandal, Kadapa district to7.00 % Guntakal mandal, Anantapuramu district.

When all the cropping system compared Kharif – Fallow had recorded highest disease incidence (19.00%) in Ayyalur of Nandyal mandal, Kurnool district and lowest was recorded with Blackgram-Chickpea cropping system (2.00%) in Daseripalem village of Rompicherla mandal, Guntur district. The per cent disease incidence recorded in different villages varied with respect to the variety previous crop.

Another important agronomic practise which play on important role in the management of soil borne disease during the initial stages of crop growth is seed treatment. Out of 22 locations, seed treatment was practised in 9 villages while maximum farmers from 13 villages did not practice seed treatment. The per cent disease incidence varied from 2.00 % in (Daseripalem, village of Rompicherla mandal, Guntur district to 7.00 in Ayyavaripalli of Guntakal mandal, Anantapuramu district where seed treatment was practiced while it was from 6.00 (Chejerla of Ongole mandal, Prakasam district) to 19.00 (Ayyalur of Nandyal mandal, Kurnool district) where no seed treatment was practiced. Comparatively in locations where seed treatment was followed had less disease incidence compared to locations where no seed treatment was practiced. Disease incidence ranged from 2.33% in Kodumure village of Kodumur mandal to 5.67 % in Chapirevula village of Nandyal mandal where seed treatment was done while it varied 7.67 % in L. Peta village of Kurnool mandal to 19.00 % in Ayyalur of Nandyal where no seed treatment was practiced in Kurnool district. The difference in maximum and minimum disease incidence was significant.

In Kadapa, per cent disease incidence was ranged from 4.00 (in Devagudi village of Jammulamadugu mandal) to 6.00 in Dharmapuram village of Jammalamadugu mandal where seed treatment was done but significantly lower per cent disease was observed in Ramapuram villages of Prodduture mandal whiel significantly higher per cent disease incidence was observed in Dhorasanipalli village (14.00) of Prodduture mandal where no seed treatment was practiced.

In Prakasam, per cent disease incidence of 2.67 was recorded from Cheruvukommapalem village of Ongole mandal) to 13.33 in villages where no seed treatment was practiced and the difference in minimum and maximum disease was significant.

In Anantapuramu disease was 7.00 % in Ayyavaripalli village of Guntakal mandal where the seed treatment was done. While significantly lowest and highest disease observed in Nakkanadoddi village (10.65% ) of Guntakal mandal a respectively where no seed treatment was practiced while in Guntur district the per cent incidence was varied from 2.00 ( Daseripalem of Rompicherla mandal) to 4.67 (Brahmanapalli of vinikonda mandal) where seed treatment was practiced but it was 13.00 in Gogulapadu village of Rompicherla where no seed treatment was practiced.

Soil moisture plays on important role in the development of the crop. It also plays a major role in the survival and spread of the disease like dry root rot caused by *R. bataticola* which favours low moisture conditions. Knowledge on the irrigation facility and soil moisture status helps in determining the per cent of disease incidence. During survey it was observed that irrigation was given in only in 2 villages of Guntur district district where the disease incidence ranged from 13.00 % (Gogulapadu village of Rompicherla mandal) and 2.00 % in

Daseripalam of Rompicherla mandal and the difference in disease incidence was significant. In the rest of the villages crop was cultivated under residual soil moisture or rainfall during crop growth where the disease incidence was maximum in Ayyalur (19.00%) of Nandyal mandal and lowest (2.33 %) in Chapirevula village of Nandyal mandal, Kurnool district. Comparatively the disease was less in irrigated fields over unirrigated ones.

In Kurnool, Kadapa, Prakasam and Anantapuramu districts the crop was grown under residual soil moisture conditions or there was no irrigation facility for crop growth where the per cent disease incidence varied from 2.33 (Chapirevula village of Nandyal mandal) to 19.00 (Ayyalaure village of Nandyal mandal), 4.00 (Devagudi of Jammalamadugu) to 14.00 (Dhorasanipalle of Prodduture mandal), 3.00 (Cheruvukammapalem of Ongole) to 13.33 (Value of Tanguture mandal) and 7.00 (Ayyavaripalli of Guntakal mandal) to 15.00 (Peddadoddi of Gooty mandal) respectively.

In Guntur district the disease incidence ranged from 4.33 % (Dondapadu village of Vinikonda) to 4.67 % (Brahmanapalli village of Vinikonda) where crop was cultivated under residual soil moisture conditions but highest and lowest disease incidence was observed in Gogulapadu village (13.00 %) of Rompicherla mandal and Daseripalem of Rompicherla mandal (2.00 %) respectively where the crop was cultivated under irrigated conditions. In all the districts surveyed the crop was cultivated in black soils.

Similar results were also recorded by Bajpal (1999) as hot and dry weather in vertisols favoured more disease incidence compared to alfisols. Gurha & Trivedi (2008) observed up to 60% dry root rot incidence in Gulberga and Raichur. Ghosh et al., (2013) also observed per cent disease incidence ranged from 8.9 to 10.3 irrespective of cultivar and locations. Local cultivars (desi) were most frequently grown by the farmers. Seed treatment was practiced by 63 per cent of the farmers where the disease incidence was low in their fields compared to fields in which no seed treatment was practised. Infected crop residues are one of the most important sources of survival and dispersal of *R. bataticola* in the field. Degradation of plant debris and relative longevity of *R. bataticola* depends upon soil moisture and temperature (Baird et al., 2003). *R. bataticola* populations in soybean root debris in the soil tend to increase over time. Root debris at or near the soil surface increases the pathogen population more rapidly than buried residue, but surface residues are more directly exposed to environmental variations (Short et al., 1978). Irrigation throughout the soybean growth reduced the population and colonization of *R. bataticola* on roots compared with unirrigated cropping system, even though the propagules remain during the season in both systems and no disease symptoms in soybean plants were recorded in the irrigated field (Kendig et al., 2000). Substances found in flooded soils such as alcohols, volatiles and alleviate the levels of $CO_2$ might had adverse effect on the inoculum (Wyllie et al., 1984).

Similarly, Kumar (2004) recorded an incidence of 9.97 per cent dry root rot of chickpea in Gulbarga followed by Raichur (5.16 %) and Bidar (4.28 %). The highest incidence was 12.24 % in Chittapur of Gulbarga and least was in Raichur (3.21 %). Mono cropping with narrow spacing and also drought and high temperature alleviated the vulnerability of the crop and enhanced the aggressiveness of the pathogen. The present findings are also supported by Garrett et al., (2006), Kaur et al., (2012) and Sharma et al., (2015). Srinivas (2016) reported through survey that per cent disease incidence was ranged from 6.67 to 15.33 in Karnataka and 0.67 to 3.33 in Andhra Pradesh at different villages.

**Table 1: Occurrence and distribution of dry root rot of chickpea in five major chickpea growing regions of Andhra Pradesh**

| S.No | District | Mandals | Villages | No. of fields visited | Variety | Seed treatment | Soil type | Previous crop | Irrigation facility | Per cent disease incidence |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Kurnool | Kurnool | L. Peta | 3 | JG 11 | No | Black | Maize | No | $7.67^{j}$ (16.02) |
| | | | Peddapadu | 3 | JG 11 | No | Black | Kharif fallow | No | $12.33^{cdefg}$ (20.53) |
| | | Kodumure | Kodumure | 3 | JG 11 | Yes | Black | Pigeon pea | No | $5.67^{jklm}$ (13.68) |
| | | | Venkatagiri | 3 | Desi | No | Black | Sorghum | No | $10.67^{hi}$ (19.02) |
| | | Nandyal | Ayyalur | 3 | L 550 | No | Black | Kharif fallow | No | $19.00^{a}$ (25.83) |
| | | | Chapirevula | 3 | JG 11 | Yes | Black | Maize | No | $2.33^{opqr}$ (8.74) |
| | | | | | | | | | **Mean** | 9.61 (17.30) |
| **2.** | Kadapa | Jammalamadugu | Dharmapuram | 3 | MNK 1 | Yes | Black | Rice | No | $6.00^{jkl}$ (14.14) |
| | | | Devagudi | 3 | JG 11 | Yes | Black | Cotton | No | $4.00^{lmnop}$ (11.47) |
| | | Prodduture | Dhorasanipalli | 3 | Desi | No | Black | Maize | No | $14.00^{bc}$ (21.96) |
| | | | Ramapuram | 3 | Desi | No | Black | Maize | No | $7.67^{j}$ (16.06) |
| | | | | | | | | | **Mean** | 7.92 (15.91) |
| **3.** | **Prakasam** | Ongole | Cheruvukommapalem | **3** | JG 11 | Yes | Black | Kharif fallow | No | $3.00^{nopq}$ (9.54) |
| | | | Chejerla | **3** | KAK 2 | No | Black | Kharif fallow | No | $6.00^{jkl}$ (14.14) |
| | | Tanguture | Kandukuru | **3** | Desi | No | Black | Kharif fallow | No | $7.67^{j}$ (16.02) |
| | | | Vallure | **3** | JG 11 | No | Black | Cotton | No | $13.33^{bcde}$ (21.41) |
| | | | | | | | | | **Mean** | 7.5 (15.28) |
| **4.** | **Anantapuramu** | Gooty | Peddadoddi | **3** | Desi | No | Black | Sorghum | No | $15.00^{b}$ (22.77) |
| | | | Basinapalle | **3** | JG 11 | No | Black | Sorghum | No | $13.33^{bcd}$ (21.39) |
| | | Guntakal | Ayyavaripalli | **3** | JG 11 | Yes | Black | Rice | No | $7.00^{jk}$ (15.31) |
| | | | Nakkanadoddi | **3** | JG 11 | No | Black | Maize | No | $10.67^{h}$ (19.04) |
| | | | | | | | | | **Mean** | 11.50 (19.63) |
| **5.** | **Guntur** | Vinikonda | Brahmanapalli | **3** | JG 11 | Yes | Black | Blackgram | No | $4.67^{lmn}$ (12.35) |
| | | | Dondapadu | **3** | JG 11 | Yes | Black | Cotton | No | $4.33^{lmno}$ (11.89) |
| | | Rompicherla | Gogulapadu | **3** | Desi | No | Black | Blackgram | Yes | $13.00^{bcdef}$ (21.12) |
| | | | Daseripalem | **3** | Desi | Yes | Black | Blackgram | Yes | $2.00^{pqr}$ (8.13) |
| | | | | | | | | | **Mean** | 6.00 (13.37) |
| | | | | | | | | | C.D (P=0.05 %) | 2.01 (2.47) |
| | | | | | | | | | SEm (±) | 0.70 (0.86) |
| | | | | | | | | | SE (d) | 0.99 (1.22) |
| | | | | | | | | | C.V | 14.14 (9.10) |

**Note**: Values in the parenthesis are angular transformed values.
The figures with similar alphabet do not differ significantly.

## SUMMERY AND CONCLUSIONS

Dry root rot of chickpea distributed in all the five districts of Andhra Pradesh. Maximum dry root rot incidence was observed in Anatapuramu (11.50%) least was observed in Guntur (6.00%). Out of 22 villages surveyed, the crop was cultivated in black soils in all locations. The per cent disease incidence recorded in each variety varied depending on the place of cultivation.

When compared to all the cultivars, desi variety had recorded minimum disease incidence 2.00% in Daseripalem of Rompicherla mandal and maximum was recorded with L550 variety at Ayyalur of (19.00%) Nandyal mandal, Kurnool district. When all the cropping system compared Kharif – Fallow had recorded highest disease incidence (19.00%) in Ayyalur of Nandyal mandal, Kurnool district and lowest was recorded with Blackgram-Chickpea cropping system (2.00%) in Daseripalem village of Rompicherla mandal, Guntur district. The per cent disease incidence recorded in different villages varied with respect to the variety previous crop. Out of 22 locations, seed treatment was practised in 9 villages while maximum farmers from 13 villages did not practice seed treatment. The per cent disease incidence varied from 2.00 % in (Daseripalem, village of Rompicherla mandal, Guntur district to 7.00 in Ayyavaripalli of Guntakal mandal, Anantapuramu district where seed treatment was practiced. Irrigation was given in only in 2 villages of Guntur district where the disease incidence ranged from 13.00 % (Gogulapadu village of Rompicherla mandal) and 2.00 % in Daseripalam of Rompicherla mandal and the difference in disease incidence was significant.

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